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MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1 2022/2023 (TERM ID: 2210)

DMA5101 – MATHEMATICAL TECHNIQUES 1
(TCIL)

8 FEBRUARY 2023
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

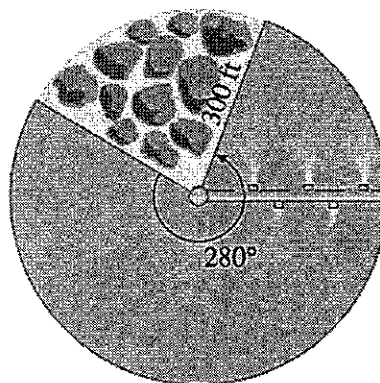
1. This question paper consists of 4 pages (3 pages with 5 questions and 1 page of appendix). Key formulae are given in the Appendix.
2. Answer ALL questions.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary working steps must be shown.

QUESTION 1**[10 Marks]**

- a) A rock is thrown upward from the top of a 112-foot-high cliff overlooking the ocean at a speed of 96 feet per second. The rock's height H (in feet) above ocean can be modeled by the equation $H(t) = -16t^2 + 96t + 112$, where t is time measured in seconds.
- Express $H(t)$ in completed square form and determine the time at which the rock reaches its maximum height and find the maximum height. (2 marks)
 - How long will it take for the rock to hit the ocean? (2.5 marks)
 - Sketch the graph of the function $H(t)$. (1.5 marks)
- b) Given $f(x) = (x^2 - 9)(x^2 + 4x + 4)$. Find the x -intercepts. State whether the graph crosses the x -axis, or touches the x -axis and turns around, at each intercept. Find the end behaviour of $f(x)$ and sketch its graph. (4 marks)

QUESTION 2**[11 Marks]**

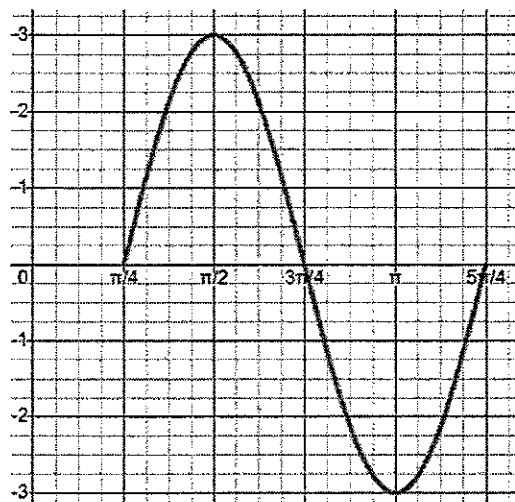
- a) An irrigation system uses a straight sprinkler pipe 300 ft long that pivots around a central point as shown. Due to an obstacle, the pipe is allowed to pivot through 280° only. Find the exact area irrigated by this system in terms of π . Then, round the value to three significant figures. (1 marks)



- b) A 20-ft ladder leans against a wall so that the angle between the ground and the ladder is 72° . How high does the ladder reach on the wall? (1.5 marks)
- c) Given $w = \sqrt{3}(\cos 60^\circ + i \sin 60^\circ)$. Use De Moivre's Theorem to find w^8 . Hence, write w^8 in the standard form $a + bi$. (Leave your answer in fraction form). (2.5 marks)

Continued...

d) Given below is the graph for a sine function.



- Determine the amplitude, period and phase shift. (2 marks)
- Identify the sine function $y = A \sin(Bx - C)$ for this graph by finding the values of A , B and C . (4 marks)

QUESTION 3

[13 Marks]

- a) The number of online sales made via two websites on a particular weekend is shown in the table below. Both online shopping websites sell each clothing at RM x and each pair of shoes at RM y . Salora and Uneedlo accumulated RM 759 and RM 817 respectively from their online sales.

	Clothing	Shoes
Salora	18	15
Uneedlo	9	20

Calculate the price for each clothing, x and the price for each pair of shoes, y by using the **inverse matrix method**. (4.5 marks)

- b) Given a system of equations below:

$$\begin{cases} 5x + 3y + 4z = -3 \\ 4x - 6y - 6z = 6 \\ 6x + z = -3 \end{cases}$$

Solve the linear system by using the **Cramer's Rule method**.

(8.5 marks)

Continued...

QUESTION 4**[7 Marks]**

- a) Find the area of a triangle PQR enclosed by the vectors $\overrightarrow{PQ} = \langle -2, 3, -1 \rangle$ and $\overrightarrow{PR} = \langle 0, -1, 2 \rangle$. (2.5 marks)
- b) Find an equation of the plane that passes through the point $(10, 5, 5)$ and with normal vector $10\mathbf{i} + 8\mathbf{j} + 3\mathbf{k}$. (1.5 marks)
- c) Find, to the nearest degree, the angle between the planes $-9x - 6y + 5z = -8$ and $2x + 2y + 7z = -8$. (3 marks)

QUESTION 5**[9 Marks]**

- a) Solve the rational inequality $\frac{w^2+5w-6}{w-3} \geq 0$. (3 marks)
- b) Find the values of x such that $|2x + 3| - 3 \geq 10$. (2.5 marks)
- c) Expand the logarithmic expression $\ln \sqrt[3]{\frac{x^2\sqrt{2-x}}{(2x+1)^5}}$ into sums of logarithmic functions with linear inputs. (1.5 marks)
- d) Solve the cubic polynomial $x^3 + 3x^2 - x - 3 = 0$. (2 marks)

Continued...

APPENDIX

Quadratic formula:

If $ax^2 + bx + c = 0$ where $a \neq 0$, then
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Standard form of a quadratic function:

$$f(x) = a(x - h)^2 + k, a \neq 0$$

Trigonometric functions:

$$y = A \sin(Bx - C) \quad \text{or} \quad y = A \cos(Bx - C)$$

$$\text{amplitude} = |A|, \text{ period} = \frac{2\pi}{B}, \text{ and phase shift} = \frac{C}{B}$$

Products and quotients in polar form:

$$z_1 z_2 = r_1 r_2 [\cos(\theta_1 + \theta_2) + i \sin(\theta_1 + \theta_2)]$$

$$\frac{z_1}{z_2} = \frac{r_1}{r_2} [\cos(\theta_1 - \theta_2) + i \sin(\theta_1 - \theta_2)]$$

De Moivre's theorem:

$$z^n = r^n [\cos(n\theta) + i \sin(n\theta)]$$

Length of vector:

The length of the vector $\mathbf{a} = \langle a_1, a_2, a_3 \rangle$ is $|\mathbf{a}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$.

Dot Product

If θ is the angle between the vector $\mathbf{a} = \langle a_1, a_2, a_3 \rangle$ and $\mathbf{b} = \langle b_1, b_2, b_3 \rangle$, then

$$\mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3 = |\mathbf{a}| |\mathbf{b}| \cos \theta$$

Cross Product

If θ is the angle between the vector $\mathbf{a} = \langle a_1, a_2, a_3 \rangle$ and $\mathbf{b} = \langle b_1, b_2, b_3 \rangle$, then

$$\mathbf{a} \times \mathbf{b} = \langle a_2 b_3 - a_3 b_2, a_3 b_1 - a_1 b_3, a_1 b_2 - a_2 b_1 \rangle$$

$$\text{Area of triangle } PQR = \frac{1}{2} \left| \vec{PQ} \times \vec{PR} \right|$$

Equation of lines

Vector equation: $\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$

Equation of planes

Scalar equations: $a(x - x_0) + b(y - y_0) + c(z - z_0) = 0$

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